THE KAKADU DUNNART, *SMINTHOPSIS BINDI* (MARSUPIALIA: DASYURIDAE), A NEW SPECIES FROM THE STONY WOODLANDS OF THE NORTHERN TERRITORY

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Sminthopsis bindi sp. nov. is described from the stony woodlands of the 'Top End' of the Northern Territory, Australia. This small-sized species with striate apical granules on the unfused interdigital pads of the hindfeet, closely resembles *S. archeri* and *S. butleri*. It is distinct, however, for its development of entoconids on the lower molars. Cladistic analysis suggests the affinities of *S.bindi* lie most closely with the *S.archeri*, *S.butleri*, *S.virginiae*, *S.douglasi* sub-clade. ☐ *Sminthopsis bindi, dunnart, Kakadu National Park, Northern Territory, dasyurid.*

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The genus *Sminthopsis* represents one of the most successful and diverse extant groups of marsupials on the Australian continent. Radiation and speciation appear to have closely followed trends of increasing continental aridity and at least nineteen species are recognised (Mahoney & Ride, 1988) from habitats ranging from arid grasslands and deserts (Archer, 1981) to highland tropical rainforest (Van Dyck, 1985). In Papua New Guinea, where *Sminthopsis* is a recent invader, the genus is represented by two savannah-adapted species *S. virginiae* and *S. archeri*.

One of these, *S. virginae*, was until recently, the only *Sminthopsis* recorded from the northern regions of the Northern Territory. However, on 25 October 1980, J.C. Wombey (CSIRO) collected a very young specimen of *Sminthopsis* (CM15587) in a pit trap set in open forest off the Arnhem Highway, west of Kapalga. The site was situated on an unnamed creek between the West Alligator River and Flying Fox Creek in Kakadu National Park, Northern Territory. The specimen was sent to John Calaby, (formerly of CSIRO, Canberra), who examined it and then sent it on to one of us (SVD) for comment. At the time it was concluded that this specimen represented a juvenile of *S. macroura*, and the specimen was referred to as *S. macroura* in the literature (Braithwaite, 1985; Brooker & Braithwaite, 1988). Later, having trapped an adult on the Mary River in November 1988, Woinarski et al. (1989a) commented on the dubious nature of the earlier *S. macroura* references, and chose instead to favour a possible *S. butleri* determination for the Kapalga and Mary River specimens. During the following 1989 wet season, CSIRO staff trapped a further nine dunnarts from Plumtree Creek, Gerowie, Mt Evelyn and Snake Plain, all within Stage III of Kakadu National Park. In April 1989, on the basis of foot and dental morphology, the Mary River specimen was taxonomically appraised as an undescribed species and in October that year Woinarski et al. (1989b) noted the determination. Since then a small number of additional specimens has come to hand primarily through the Kakadu Stage III Fauna Survey. These specimens all confirm the early contention of Calaby that the Kapalga specimen represented a new species of dunnart. The species is described here as *S. bindi* and its close affinities with the *S. archeri, S. butleri, S.virginiae, S. douglasi* group are discussed.

METHODS

Terminology of cranial, external and dental morphology follows Archer (1976a, 1981). Tooth number follows Luckett (1993). Some extra measurements follow Van Dyck (1986). The HENNIG '86 V1.5 programme (James S. Farris, 1988) was used to formulate the most parsimonous hypothesis of relationship between *S. bindi* and other species of the genus; mhennig* and bb (branch breaker) options were used on unweighted branches using default coding. Seventy-nine characters were used in the analysis (Tables 2, 3). 17 pertained to the incisors, 5 to canines, 15 to premolars, 20 to molars, 8 to cranium and 14 to external features. Polarity for many of these characters has been established in prior works such as Archer (1976b, 1981, 1982a, 1982b) and Kirsch & Archer (1982). The coded characters were treated as ordered. This analysis produced a single, well-resolved cladogram of dunnart relationships with a consistency index of 0.41. *Murexia longicaudata* and *Antechinus godmani* were used as outgroup species. A climate profile (Table 5) was generated by the BIOCLIM prediction system (see Nix & Switzer, 1991). Specimens mentioned here are lodged in the collections of the Queensland Museum (prefixed JM), Northern Territory Museum (U) and the Australian National Wildlife Collection, Division of Wildlife Research, Canberra (CM).

SYSTEMATICS

Sminthopsis bindi sp. nov.
(Figs 1, 2; Tables 1, 4)

ETYMOLOGY

'Bindi' is the name for small dasyurids in the language of the Jawoyn people, traditional owners of the land from which most specimens have been recorded (Sandy Barruwei, Peter Jatbula and Nipper Cooper, as told to David Cooper).

TYPE LOCALITY

Eva Valley Station, Stage 3 Kakadu National Park, Northern Territory, 14°30'S, 132°45'E.

MATERIAL EXAMINED

HOLOTYPE: NTMU944, adult male, skull and dentaries, body in ethanol, 22 Feb 1991, J. Woinarski.

PARATYPES: A total of seven (Table 1).

DIAGNOSIS.

A small-sized species of *Sminthopsis* that differs from *S. murina, S. dolichura, S. griseoventer, S. gilberti, S. aitkeni, S. ooldea, S. granulipes, S. psammophila, S. butleri, S. hirtipes, S. macroura, S. crassicaudata* and *S. youngsoni* in having the apical granules of the non-fused interdigital pads of the very narrow hindfeet large, oval and striate. Differs from *S. virginiae* in being much smaller [mean basicranial length (BL)=23.40mm (SD=0.70, N=5, R=22.95-24.40) vs BL=27.06 (SD=1.48, N=7, R=24.95-29.19), mean lower premolar row length (P_{1-3})=3.00 (SD=0.19 N=5, R=2.88-3.30) vs P_{1-3}=3.83 (SD=0.16, N=7, R=3.67-4.11), mean hind foot width (HFW)=3.09 (SD=0.16, N=5, R=2.94-3.31) vs HFW=4.89 (SD=0.36, N=12, R=4.50-5.66)], lacking rufous cheeks and having less well-developed entoconids. Differs from *S. longicaudata* in having a tail that is less than twice the nose-vent length. Differs from *S. douglasi* in being much smaller [mean BL=23.40 vs 28.90 (SD=3.11, R=26.7-31.10, N=2), mean P_{1-3}=3.00 vs 4.02 (SD=0.30, R=3.81-4.23, N=2), mean HFW=3.09 vs 5.30 (N=1)], lacking an incrassated tail, and having less well-developed entoconids. Differs from *S. leucopus* and *S. archeri* in possessing entoconids on M_{1-3}. Differs from *Antechinomys laniger* in lacking terminal brush on tail.

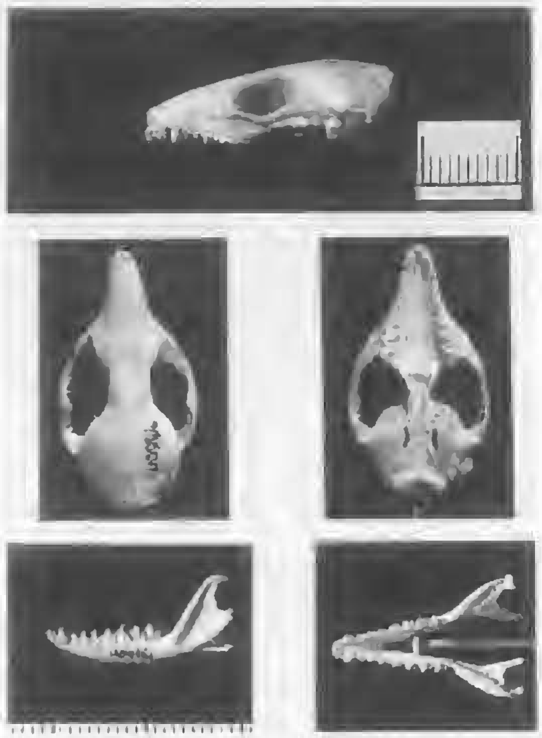

FIG. 1. *Sminthopsis bindi*, skull and dentaries of holotype, NTMU944. Scale in mm.

DESCRIPTION

This diminutive, broad-faced dunnart (Fig. 2) is characterised by sandy dorsal tonings, white belly, short-haired non-incrassated tail and distinctive eye-rings. There is little variation in the depth of tonings of specimens.

Holotype: *Pelage*. Colours (after Ridgway, 1912) for holotype are as follows; fur of mid-back (7mm long) with basal 4mm Slate Color, median 2.5mm Chamois, apical 0.5 mm black. Back appears

TABLE 1. Paratypes.

Reg. No.	Age	Sex	Locality	Collection date	Collector	Preservation
NTMU716	Adult	Male	El Sherana Plateau(Kakadu NP Stage III) 13°31'S 132°33'E	1.8.90	A. Fisher	Spirit body, skull extracted
NTMU943	Juvenile	Male	Eva Valley 14°30'S 132°45'E	2.2.91	J. Woinarski	Spirit
NTMU945	Juvenile	Male	Stuart Highway 12°51'S 131°08'E	4.11.90	R. Chatto	Spirit
NTMU946	Adult	Male	Arnhem Highway 12°53'S 131°40'E	21.10.90	R. Chatto	Spirit
NTMU954	Subadult	Female	Roper Valley Station 14°55'S 133°54'E	27.5.91	J. Woinarski	Spirit
CM15587	Juvenile	Male	West of Kapalga 12°46'S 132°15'E	25.10.80	J.C. Wombey	Puppet skin, skull extracted
QMJM10121	Adult	Male	James Mine Adit Mt Todd area 14°07'S 132° 08'E	8.12.89	M. Schulz	Spirit

overall Citrine-Drab. Medially-thickened Fuscous Black spines (guard hairs) interspersed thinly through the fur 8 mm long on the rump and reduced to 5.5mm where they terminate at the crown of the head. Fur on and below the shoulders, thighs, flanks and chin lacks black tips or coarse guard hairs and these areas and the belly appear Dark Olive-Buff.

Holotype lacks distinct head-stripe, but light areas immediately above each eye-ring leave the impression of a dark head "patch". A distinct eye-ring results firstly from an intense darkening of the eyelid skin (similar in intensity to the dark pigmentation of the scrotal skin) and secondly from the dark hairs which surround the eye. A narrow band of short, black, eyelash-hairs completely encircles the eye. Fur immediately under the eye is off-white (Pale Olive-Buff) giving the impression of white cheeks. The soft ventral fur (4.5mm long on belly and 4mm long on interramal region) is white and is interspersed by white medially-thickened spines up to 7 mm long. Belly is overall white. Forefeet thinly covered with short white hairs. Hindfeet more thickly covered with short white hairs. Tail weakly bicoloured with hairs averaging 1.0mm along its length and increasing to 2.2mm at its tip. Dorsally, hairs of tail uniform Pale Olive-Buff with Buffy Brown to Fuscous Black tips. Ventrally, black tips lost completely and hairs are Pale Olive-Buff. However, the dark pigmentation of the tail scales gives the overall impression of a tail coloured Buffy Brown dorsally and Vinaceous-Buff ventrally.

Vibrissae. Approximately 25 mystacial vibrissae occur on each side and are up to 21mm long. More dorsal mystacial vibrissae are coloured Fuscous Black while those more ventral are colourless; supraorbital vibrissae (Fuscous Black) number 2 (right) and 1 (left); genals (Fuscous Black and colourless) number 10(right) and 9 (left); ulna-carpals (colourless) number 2 (left) and 2 (right); submentals (colourless) number 4.

Tail. Tail longer than nose-vent length. Thin and tapers toward tip.

Hindfoot. Very narrow. Interdigital pads separate. Apical granule enlarged, elongate and striate. Small hallucal granules present. No metatarsal granules present. Hair on foot covers heel and extends diagonally across foot. Terminal pads of digits also striate (Fig. 3).

Ears. Ears large with curled external edge on supratragus. Fawn hairs on posterointernal and ventral margins of pinnae.

Dentition. (Figs 1, 4). Upper incisors: I^1 narrow, peg-like, non-procumbent and relatively uncurved, taller-crowned than all upper incisors and separated by diastema from I^2. Left and right I^1 worn and very widely separated. For $I^{2\text{-}4}$ overall crown size $I^4 = I^3 > I^2$. I^2 and I^3 have very weak buccal cingula. There is no lack of differentiation between root and crown. I^4 carries a very weak anterior and posterior cusp . Roots of I^4 narrow.

Upper canines: C^1 slender, short and caniniform with indistinct boundary between root and crown. No buccal cingulum, no lingual cingulum. Minute anterior cusp present as well as minute posterior cusp.

Upper premolars: Minute gaps between C^1 and P^1, P^1 and P^2, P^2 and P^3. All upper premolars carry

FIG. 2. Adult female and young *Sminthopsis bindi*. (Photo : Martin Armstrong).

weak buccal cingula. P^2 and P^3 carry weak lingual cingula. Crown height of $P^1 < P^2 < P^3$. Minute but clearly-defined anterior and posterior cingular cusps on P^1, P^2 and P^3. P^3 exhibits a slight postero-lingual lobe.

Upper molars: Posterior tip of P^3 near parastylar corner of M^1 but lingual to and below stylar cusp A. Anterior cingulum of M^1 below stylar cusp B short, broad and complete. Stylar cusp B and paracone relatively unworn and no protoconule present at base of paracone apex. Small bulge of enamel on face of anterior protocrista. Paracone on M^1 approximately one third height of metacone. Stylar cusps C and E not visible on either LM^1 or RM^1. M^1 lacks posterior cingulum.

In M^2 very narrow incomplete anterior cingulum, which contacts metastylar corner of M^1, tapers quickly along base of paracrista and degenerates well labially to base of paracone apex. Protoconule absent. M^2 lacks stylar cusps A, C and E. Stylar cusp D spinous and narrow and there is no posterior cingulum.

In M^3 anterior cingulum greatly reduced and narrower than in M^2, becomes indistinct after covering half the distance between stylar cusp B and base of paracone. No evidence of anterior cingulum at base of paracone and no protoconule or enamel bulge. Stylar cusp D reduced to very small, blunt peak. Stylar cusp E a minute point, but stylar cusp C absent.

In left M^4 anterior cingulum narrow and terminates half way between stylar cusp B and base of paracone. Posterior cingulum is absent. Protocone reduced, short and relatively narrow. In occlusal view angle made between postprotocrista and lingual profile of enamel below metastylar corner close to 120°. Right M^4 deformed and amorphous posterior to paracrista.

Lower incisors: Crown height in first lower incisor greater than crown height in I_2. I_1 and I_2 oval in anterolaterial view and gouge-like in occlusal view. I_2 greater in crown height than I_3. I_3 slightly premolariform in lateral view with small posterior cusp at base of crest which descends posteriorly from apex of primary cusp. Lower canine rests against this posterior cusp. In occlusal view, a small notch separates posterior cusp from posterolingual lobe and crown enamel of primary and posterior cusps folds noticeable lingually such that the crest of the two cusps bisects tooth longitudinally.

Lower canines: C_1 caniniform and characterised by forward, incisor-like projection and

FIG. 3. Left hindfoot of *Sminthopsis bindi* holotype , NTMU944.

minimal curvature from root to crown tip. It has weak buccal and stronger lingual cingula and a very small posterior cusp.

Lower premolars: P_1 close to C_1. All premolars close but not touching. All weakly cingulated buccally and very weakly lingually. For crown height and length $P_3 > P_2 > P_1$. All premolars narrow and elongate. All possess posterior cusps, and minute anterior cusps. Bulk of each premolar mass concentrated anteriorly to line drawn transversely through middle of the two premolar roots.

Lower molars (Fig.4): All molars narrow. M_1 talonid wider than trigonid and anterior cingulum very poorly developed. It terminates at posterior base of protoconid. No buccal cingulum. Low narrow paraconid appears in occlusal view as small blunt spur, lingual edge of which makes a

FIG. 4. Molar row of left dentary showing development of entoconids, holotype, NTMU944.

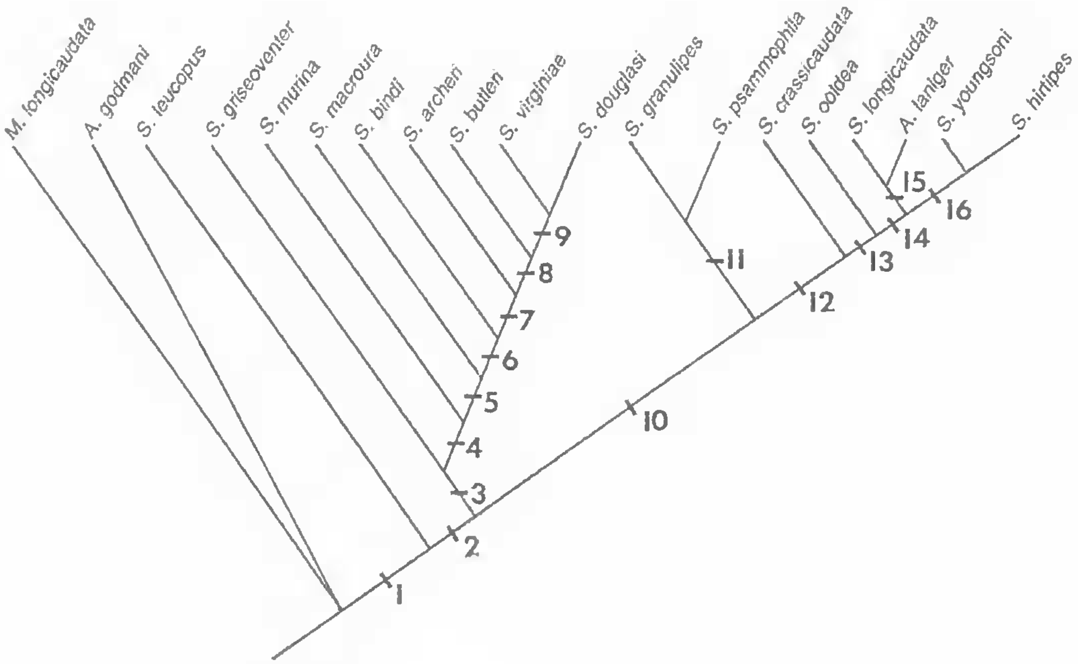

FIG. 5. The most parsimonous cladogram of 17 species of extant *Sminthopsis* (sensu Archer, 1982) when the outgroup contained *A. godmani* and *M. longicaudata.*

[Characters supporting the nodes in Fig. 5 are as follows (interpret character numbers from Table 2):

Node 1: non-homoplasious forward changes - 16(3), 19(1), 28(2), 36(2), 53(3), 54(1), 56(1), 62(1), 63(2), 79(2); homoplasious forward changes - 30(2) also at nodes 6, 9, 12, and in *M. longicaudata, A. laniger* and *S. hirtipes*, 32(4) also at nodes 8 and 13 and in *M. longicaudata, S. granulipes* and *A. laniger*, 70(1) also at nodes 2, 6, 9, 10, 11, 14, 16 and in *S. butleri, S. ooldea, A. laniger* and *S. hirtipes.*

Node 2: non-homoplasious forward changes - 58(1); homoplasious forward changes - 23(1) also in *A. godmani, S. archeri, S. douglasi, S. psammophila, S. ooldea, A. laniger* and *S. youngsoni*, 25(1) also at nodes 5, 13 and in *A. godmani, S. butleri, S. douglasi* and *S. longicaudata*, 42(1) also at node 15 and in *A. godmani, S. murina, S. granulipes, S. psammophila, S. ooldea*, 70(2) also at nodes 1, 6, 9, 10, 11, 14, 16 and in *S. butleri, S. ooldea, A. laniger* and *S. hirtipes*; non-homoplasious reversals - 1(0).

Node 3: homoplasious forward changes - 41(1)also at nodes 5, 11, 16 and in *S. psammophila*, 45(1) also at node 16 and in *S. archeri, S. virginiae* and *S. ooldea*, 58(2) also at nodes 2, 4, 5, 6 and in *S. butleri, S. virginiae, S. granulipes, S. psammophila, S. longicaudata, A. laniger* and *S. hirtipes*; homoplasious reversals - 5(0) also at nodes 8, 11 and in *M. longicaudata, A. godmani, S. douglasi, S. ooldea, A. laniger* and *S.hirtipes.*

Node 4: non-homoplasious forward changes - 58(3); homoplasious forward changes - 47(1) also in *S. ooldea*, 59(1) also at nodes 5, 14 and in *M. longicaudata, S. leucopus, S. macroura, S. butleri, S. longicaudata and S. hirtipes.*

Node 5: homoplasious forward changes - 4(2) also at nodes 11, 15 and in *M. longicaudata, S. murina, S.douglasi* and *S. granulipes*, 59(2) also at nodes 4 and 14 and in *M. longicaudata, S. leucopus, S. macroura, S. butleri, S. longicaudata* and *S. hirtipes*; homoplasious reversals - 2(0) also at node 9 and in *M. longicaudata, S. douglasi, S. granulipes, S. psammophila, S. crassicaudata, S. ooldea, S. hirtipes* and *S. youngsoni*, 25(0) also at nodes 2, 13 and in *A. godmani, S. butleri, S. douglasi* and *S. longicaudata*, 41(0) also at nodes 3, 11, 16 and in *S. psammophila.*

Node 6: homoplasious forward changes - 24(1) also in *S. youngsoni*, 30(3) also at node 1, 9, 12, and in *M. longicaudata, A. laniger* and *S. hirtipes*, 52(1) also at nodes *9, 12, 16* and in *S. psammophila*, 58(5) also at nodes 2, 4, 5, and in *S. butleri, S. virginiae, S. granulipes, S. psammophila, S. longicaudata, A. laniger* and *S. hirtipes*; homoplasious reversals - 8(0) also at nodes 11, 13 and in *S. virginiae, S. granulipes, S. longicaudata*, and *S. youngsoni*, 70(1) also at nodes 1, 2, 9, 10, 11, 14, 16 and in *S. butleri, S. ooldea, A. laniger* and *S. hirtipes.*

Node 7: homoplasious reversals - 19(0) also occurs at nodes 11, 15 and in *S. griseoventer* and *S. ooldea*, 43(0) also occurs at node 12 and in *M. longicaudata, S. murina, S. douglasi, S. ooldea,* and *S.longicaudata.*

Node 8: homoplasious forward changes - 5(1) also at nodes 3, 8, 11 and in *M. longicaudata, A. godmani, S. douglasi, S. ooldea, A. laniger* and *S. hirtipes*, 59(4) also at nodes 4, 5, 14 and in *M. longicaudata, S. leucopus, S. macroura, S. butleri, S. longicaudata* and *S. hirtipes*; homoplasious reversals - 32(3) also at nodes 1, 8, 13 and in *M. longicaudata, S. granulipes* and *A. laniger*, 79(1) also at node 1 and in *M. longicaudata, S. psammophila, S. ooldea, A. laniger* and *S. youngsoni*; non-homoplasious reversals 16(2) also at nodes 1 and 15 and in *M. longicaudata, S. douglasi* and *S. ooldea*.

Node 9: non-homoplasious forward change - 21(2) also at node 10 and in *M. longicaudata, S. ooldea*, and *S. youngsoni*; homoplasious forward changes - 1(1) also at node 2 and in *S. douglasi, S. granulipes*, and *S. hirtipes*, 2(1) also at node 5, and in *M. longicaudata, S. douglasi, S. granulipes, S. psammophila, S. crassicaudata, S. ooldea, S. hirtipes* and *S. youngsoni*, 9(1) also in *S. douglasi*, and *S. psammophila*; homoplasious reversals - 30(2) also at nodes 1, 6 and 12 and in *M. longicaudata, A. laniger* and *S. hirtipes*, 52(0) also at nodes 6, 12, 16 and in *S. psammophila*, 54(0) also at nodes 1, 13 and in *S. leucopus, S. murina, S. archeri, S. butleri* and *S. crassicaudata*, 70(0) also at nodes 1, 2, 6, 10, 11, 14, 16 and in *S. butleri, S. ooldea, A. laniger* and *S. hirtipes*.

Node 10: non-homoplasious forward change - 70(1) also at nodes 1, 2, 6, 9, 11, 14, 16 and in *S. butleri, S. ooldea, A. laniger* and *S. hirtipes*; homoplasious reversal - 21(0) also at node 9 and in *M. longicaudata, S. ooldea*, and *S. youngsoni*.

Node 11: non-homoplasious forward change - 7(2), 48(2) and 70(4); homoplasious forward changes - 4(2) also at node 5 and in *M. longicaudata, S. murina, S.douglasi* and *S. granulipes*, 5(4) also at nodes 3, 8 and in *M. longicaudata, A. godmani, S. douglasi, S. ooldea, A. laniger* and *S. hirtipes*, 8(3) occurrs also at nodes 6, 13 and in *S. virginiae, S. granulipes, S. longicaudata*, and *S. youngsonii*, 22(1) also at node 15 and in *M. longicaudata, S. granulipes* and *S. longicaudata*, 41(1) also at nodes 3, 5, 16 and in *S. psammophila*; homoplasious reversals - 18(0) also at node 15 and in *M. longicaudata, S. douglasi* and *S.hirtipes*, 19(0) also at nodes 1, 7, 15 and in *S. griseoventer* and *S. ooldea*, 35(1) also in *M. longicaudata* and *S. longicaudata*, 44(0) also in *M. longicaudata, S. macroura, S. bindi, S. douglasi, S.ooldea, A. laniger* and *S. youngsoni*.

Node 12: homoplasious forward changes - 20(1) also at node 15 and in *A. godmani, S. griseoventer, S. archeri* and *S. hirtipes*, 30(3) also at nodes 1, 6, 9 and in *M. longicaudata, A. laniger* and *S. hirtipes*, 52(1) also at nodes 6, 9, 16 and in *S. psammophila*, 68(1) also at node 15 and in *S. douglasi* and *S. granulipes*; homoplasious reversal - 43(0) also at node 7, and in *M. longicaudata, S. murina, S. douglasi, S. ooldea*, and *S. longicaudata*.

Node 13: homoplasious forward changes - 17(1) also at node 15 and in *A. godmani, S. griseoventer, S. bindi, S. archeri, S. douglasi* and *S. youngsoni*, 32(5)also at nodes 1 and 8 and in *M. longicaudata, S. granulipes* and *A. laniger*, 54(2) also at nodes 1 and 9 and in *S. leucopus, S. murina, S. archeri, S. butleri* and *S. crassicaudata*; homoplasious reversals - 8(0) also at nodes 6 and 11 and in *S. virginiae, S. granulipes, S. longicaudata, and S. youngsoni, 25(0) also at nodes 2, 5, 13 and in A. godmani, S. butleri, S. douglasi* and *S. longicaudata*.

Node 14: non-homoplasious forward change - 70(5); homoplasious forward changes 58(1) also at node 5 and in *M. longicaudata, S. leucopus, S. macroura, S. butleri, S. longicaudata* and *S. hirtipes*, 64(2) also at node 15 and in *M. longicaudata* and *S. psammophila*.

Node 15: non-homoplasious forward changes - 17(3), 18(3), 19(4), 20(2), 64(2), 65(2); homoplasious forward changes - 4(2) also at nodes 5, 11 and in *M. longicaudata, S. murina, S.douglasi* and *S. granulipes*, 16(4)also at nodes 1 and 8 and in *M. longicaudata, S. douglasi, S. granulipes* and *S.ooldea*, 22(1) also at node 11 and in *M. longicaudata, S.granulipes* and *S. longicaudata*, 69(1) also in *S. psammophila*; homoplasious reversals - 42(0) also at node 2 and in *A. godmani, S. murina, S. granulipes, S. psammophila, S. ooldea*, 67(0) also in *M. longicaudata, S. granulipes, S. psammophila, S. crassicaudata* and *S. youngsoni*, 68(0) also at node 12 and in *S. douglasi* and *S. granulipes*.

Node 16: non-homoplasious forward change - 70(7) also at nodes 1, 2, 6, 9, 10, 11, 14, and in *S. butleri, S. ooldea, A. laniger* and *S. hirtipes*; homoplasious forward changes - 41(2) also at nodes 3, 5, 11, and in *S. psammophila*, 45(1) also in *S. archeri* and *S. ooldea*; homoplasious reversals - 52(0) also at nodes 6, 9, and 12 and in *S. psammophila*].

slight swelling on endoloph of M_1. Metacristid roughly oblique to long axis of dentary while hypocristid perpendicular. Cristid obliqua very short and extends from hypoconid to posterior wall of trigonid intersecting trigonid at point directly below tip of protoconid. Hypocristid terminates two-thirds way between hypoconid and metastylid. Small entoconid. From base of metaconid posteriorly, talonid endoloph takes a more lingual orientation under the influence of the entoconid.

In M_2, trigonid slightly narrower than talonid. Anterior cingulum poorly developed and terminating lingually in weak parastylid notch into which hypoconulid of M_1 is tucked. No buccal cingulum. Narrow, weak posterior cingulum extends from hypoconulid to posterior base of hypoconid. Well-developed paraconid is smallest trigonid cusp. Metastylid minute, entoconid small but moderately well developed. Cristid obliqua extends from hypoconulid to posterior wall of trigonid, intersecting trigonid at point slightly lingual to longitudinal vertical midline

TABLE 2. Character states (defined in derived state) used to resolve the affinities of *S. bindi.* Data used are a small subset of data including representatives from the following genera: *Marmosa, Philarder, Antechinus, Phascogale, Myoictis, Dasyurus, Pseudantechinus, Parantechinus, Sarcophilus, Perorycles, Isoodon* and *Myrmecobius.* However the cladogram (Fig. 5) was based only upon taxa in Table 3. Character states are taken unchanged from those of the full data set, hence there are some discontinuities.

UPPER INCISORS

1. Incisors procumbent: 0, not procumbent; 1, slightly procumbent; 2, more than 1; 3, more than 2; 4, procumbent.
2. I^1 crown relatively bulky with cingulum low: 0, crown of I^1 a thin spur, 1, more bulky than 0; 2, bulkier than 1; 3, bulkier than 2; 4, bulkier than 3; 5, bulkier than 4; 6, I^1 crown heavy.
3. I^1 laterally compressed, elongate: 0, I^1 needle or peg-like; 1, more compressed than 0; 2, more compressed than 1; 3, more compressed than 2; 4, I^1 spade-like.
4. R and L I^1 separated by diastema: 0, touching; 1, narrowly spaced; 2, wider than 1; 3, wider than 2; 4, widely spaced.
5. I^1 non-needle-like: 0, I^1 needle-like, 1, less needle-like than 0; 2, less needle-like than 1; 3, less needle-like than 2; 4, less needle-like than 3; 5, less needle-like than 4; 6, less needle-like than 5; 7, I^1 spatulate or club-shaped.
6. I^1 and I^2 juxtaposed: 0, I^1 and I^2 widely spaced; 1, spacing less than 0; 2, spacing less than 1; 3, spacing less than 2; 4, spacing less than 3; 5, I^1 and I^2 crushed.
7. I^{2-4} crowns broader than roots: 0, crown-root width equal; 1, crown slightly broader; 2, broader than 1; 3, broader than 2; 4, broader than 3; 5, crown much broader than root.
8. I^{2-4} lensate, elongate: 0, I^{2-4} peg-like; 1, more elongate than 0; 2, more than 1; 3, more than 2; 4, more than 3; 5, I^{2-4} lensate.
9. I^{2-4} crowns broad (occlusal) and cusps folded lingually: 0, crowns narrow and cusps unfolded; 1, crowns broader and slightly folded; 2, more than 1; 3, more than 2; 4, crowns broad and folded.
10. $I^2 \geq I^3 > I^4$: 0, $I^4 > I^3 \geq I^2$; 1, $I^4 = I^3 = I^2$; 2, $I^2 \geq I^3 > I^4$; 3, $I^2 > I^3 > I^4$; 4, $I^2 >> I^3 > I^4$.
11. I^{1-4} cingulated: 0, no cingulation; 1, slight cingulation; 2, more than 1; 3, more than 2; 4, I^{1-4} heavily cingulated.
12. I^4 with posterior cusp: 0, no posterior cusp; 1, posterior cusp present.
13. Total upper incisors =8: 0, 10; 1, 8.
14. I^1 greatly enlarged: 0, no; 1, yes.
15. I^1 lower than I^{2-4}: 0, higher; 1, lower.

UPPER CANINES

16. C^1 short: 0, C^1 very long; 1, shorter than 0; 2, shorter than 1; 3, shorter than 2; 4, C^1 short.
17. C^1 root and crown clearly differentiated: 0, no differentiation; 1, differentiated; 2, more than 1; 3, more than 2; 4, more than 3.
18. C^1 bulky, non needle-like: 0, C^1 needle-like; 1, less than 0; 2, less than 1; 3, less than 2; 4, C^1 cone-shaped.
19. C^1 non-caniniform: 0, C^1 caniniform; 1, less than 0; 2, less than 1; 3, less than 2; 4, C^1 premolariform.
20. C^1 with posterior cusp: 0, cusp absent; 1, small cusp present; 2, cusp larger than 1.

UPPER PREMOLARS

21. P^1 circular in occlusal: 0, P^1 elongate; 1, more rounded than 0; 2, more rounded than 1; 3, more rounded than 2.
22. P^1 extremely lensate: 0, P^1 moderately narrow; 1, more elongate than 0; 2, more elongate than 1; 3, more elongate than 2; 4, P^1 very narrow and lensate.
23. P^1 and P^2 touching or crushed: 0, wide space between P^1 and P^2; 1, small space between P^1 and P^2; 2, P^1 and P^2 touch or crushed.
24. P^1 and P^2 with lingual lobing: 0, no lobing; 1, slight lobing; 2, pronounced lobing.
25. P^3 with large posterior cusp: 0, no cusp; 1, slight cusp; 2, pronounced cusp or P^3 absent.
26. $P^3 < P^2$: 0, no $P^2 < P^3$; 1, yes.
27. P^3 with postero-lingual cusp: 0, no; 1, yes.

UPPER MOLARS

28. M^{1-3} narrow with incomplete anterior cingulum: 0, M^{1-3} broad, cingulum complete; 1, M^{1-3} narrow, cingulum incomplete or nearly so; 2, M^{1-3} narrow, cingulum incomplete, molars very narrow; 3, molars greatly reduced.
29. M^2 equal to or shorter than M^3: 0, no; 1, yes.
30. M^{1-3} protocone width greatly reduced: 0, Protocone broad; 1, protocone narrower than 0; 2, narrower than 1; 3, narrower than 2; 4, narrower than 3; 5, protocone absent.
31. M^1 stylar cusp B greatly reduced: 0, no reduction; 1, reduced; 2, greatly reduced
32. M^4 protocone reduced: 0, protocone large; 1, protocone slightly reduced; 2, reduction greater than 1; 3, reduction greater than 2; 4, reduction greater than 3; 5, reduction greater than 4, 6, reduction greater than 5; 7, reduction greater than 6; 8, protocone absent.
33. M^4 preparacrista orients transversely to long axis of skull: 0, orientation perpendicular to longitudinal; 1, slightly transverse; 2, transverse.
34. $M^{1,2}$ stylar cusp D very large: 0, stylar cusp D absent; 1, larger than 0; 2, larger than 1; 3, stylar cusp D very large.
35. M^2, M^3 ectoloph greatly indented: 0, no; 1, slight indent; 2, more than 1; 3, greatly indented.
36. M^4 metacone loss: 0, metacone large; 1, metacone more reduced than 0; 2, more than 1; 3, more than 2; 4, metacone lost.
37. M^x posterior cingulum absent: 0, present; 1, absent.
38. M^2, M^3 metaconule greatly developed: 0, no; 1, slight development; 2, greatly developed.
39. M^1 paracone and stylar cusp B fused: 0, no, widely separated; 1, approximated; 2, greater approximation than 1; 3, fused.
40. Stylar cusp D on M^3 heavily infolded: 0, near perpendicular with ectoloph; 1, slightly infolded; 2, heavily infolded; 3, merging with metacone.

LOWER INCISORS

41. I_1, I_2 prostrate: 0, I_1, I_2 almost perpendicular to dentary axis; 1, more prostrate than 0; 2, more prostrate than 1; 3, I_1, I_2 almost horizontal.
42. I_3 heel narrower than I_1 heel: 0, I_3 heel wider than heel of I_1; 1, heels equal width; 2, I_3 heel slightly narrower than heel of I_1; 3, narrower than 2; 4, narrower than 3.

LOWER PREMOLARS

43. $P_3 < P_2$: 0, $P_3 > P_2$; 1, $P_3 \leq P_2$; 2, $P_3 << P_2$.
44. Lower premolars crushed: 0, premolars widely spaced; 1, nearly touching; 2, slightly crushed; 3, more than 2; 4, more than 3.
45. P_1, P_2 in contact: 0, widely spaced; 1, just contacting; 2, crushed.

46. P_3 broad or oriented transversely: 0, P_3 longitudinal to dentary axis; 1, P_3 broad; 2, P_3 transverse to dentary axis.

47. $P_{1\text{-}3}$ circular in occlusal view: 0, premolars elongate view; 1, premolars oval; 2, premolars round48. P_2, P_3 lenticular: 0, elongate; 1, narrower than 0; 2, narrower than 1; 3, lenticular.

49. P_1, P_2 with posterior lobing: 0, no lobing; 1, slight lobing; 2, heavily lobed.

50. P_3 single-rooted or absent: 0, neither; 1, yes, one or both.

LOWER MOLARS

51. M_1 paraconid poorly developed: 0, paraconid well developed; 1, paraconid more reduced than 0; 2, paraconid more reduced than 1.

52. M_3 talonid narrower than trigonid: 0, no; 1, yes.

53. M_4 talonid with reduced cusp number: 0, 3 cusps, well developed; 1, 3 cusps, poorly developed; 2, 2 cusps; 3, 1 cusp; 4, loss of talonid.

54. M_2 entoconid reduced: 0, entoconid tall; 1, reduced; 2, absent.

55. M_1 paraconid absent: 0, present; 1, absent.

56. $M_{1\text{-}3}$ metacristids and hypocristids perpendicular to long axis of dentary: 0, transverse; 1, perpendicular.

57. M_2, M_3 hypoconid coalesced with entoconid: 0, no; 1, yes.

CRANIAL FEATURES

58. Skull brachycephalic (ratio lachrymal breadth to length I^1-lachrymal canal): 0, elongate; 1, less elongate than 0; 2, less elongate than 1; 3, less elongate than 2; 4, less elongate than 3; 5, less elongate than 4; 6, less elongate than 5; 7, skull brachycephalic.

59. Skull brachycephalic (ratio zygomatic width to basicranial length): 0, elongate (<0.5690); 1, less elongate than 0 (0.5691-0.5890); 2, less elongate than 1 (0.5897-0.6054); 3, less elongate than 2 (0.6055-0.6300); 4, brachycephalic (>0.6300).

60. Nasals non-fluted: 0, fluted; 1, less fluted than 0; 2, less fluted than 1; 3, flat.

61. Skull flat not domed: 0, domed; 1, less than 0; 2, flat or concave.

62. Squamosal-frontal contact: 0, no; 1, yes.

63. Maxillary vacuities present: 0, absent; 1, present; 2, very large or with palatine vacuities.

64. Alisphenoid tympanic wing greatly expanded: 0, small expansion; 1, slightly inflated; 2, more inflated than 1; 3, greatly expanded.

65. Periotic wing of alisphenoid mastoid greatly expanded: 0, slight expansion; 1, inflated; 2, greatly expanded.

EXTERNAL FEATURES

66. Supratragus folded: 0, simple; 1, folded.

67. Tail short: 0, longer than head-body; 1, equal to head-body; 2, shorter than head-body.

68. Tail incrassated: 0, no, tail thin; 1, yes or capacity to fatten.

69. Tail extremely long: 0, no; 1, yes.

70. Hind foot interdigital pads: 0, large apical granules strongly striated; 1, large apical granules weakly striated; 2, large apical granules clear; 3, small apical granules; 4, no enlarged apical granules; 5, coalesced interdigitals, striated apical granules; 6, coalesced interdigitals, unstriated apical granules; 7, coalesced interdigitals, small apical granules and short hair cover; 8, coalesced interdigitals, small apical granules and long hair cover.

71. Loss of hallux: 0, no; 1, yes.

72. Hind foot heavily padded and striated post-hallucal granule: 0, no; 1, moderately; 2, yes.

73. Claws very long: 0, no; 1, yes.

74. Body striped: 0, no; 1, yes.

75. Hind feet syndactylous: 0, no; 1, yes.

76. Backward-opening pouch: 0, no; 1, yes.

77. Tail with terminal brush: 0, no; 1, yes.

78. Body size very large: 0, small; 1, medium; 2, large; 3, very large.

79. Body size very small: 0, medium; 1, smaller than 0, 2, smaller than 1; 3, very small.

drawn through tip of protoconid but well buccal to metacristid fissure. Hypocristid extends from slightly anterior and buccal to hypoconulid, to tip of hypoconid. From base of metaconid moving posteriorly, the endoloph takes a lingual orientation, then veers buccally to follow the line of the dentary until the base of the hypoconulid.

In M_3, trigonid wider than talonid. Prominent parastylid wraps around hypoconulid of M_3; a strong anterior cingulum on M_3. Posterior cingulum as in M_2 but more developed. Reduced cristid obliqua intersects trigonid at point well lingual to longitudinal vertical midline drawn through tip of protoconid, but slightly buccal to metacristid fissure. Entoconid on M_3 as in M_2 but less well developed. Endoloph on talonid of M_3 follows line of dentary axis. Rest of M_3 morphology as in M_2.

In M_4 trigonid much wider than talonid. Anterior cingulum stronger than in M_3. Posterior cingulum absent. Of three main trigonid cusps, metaconid slightly taller than paraconid but both are dwarfed by protoconid. Hypoconid of M_4 talonid similar in size to M_3. Cristid obliqua forms low crest between hypoconid and base of metacristid, which intersects trigonid at point well lingual to metacristid fissure. Talonid crown enamel below cristid obliqua is reduced, resulting in talonid appearing (in occlusal view) as narrow oblique spur jutting off trigonid wall. Entoconid remnant visible.

Skull (Fig. 1). *Sminthopsis bindi* is one of the 'broad-faced' dunnarts (others include *S. virginiae*, *S. butleri*, *S. archeri*, *S. douglasi*) which have a deep rostrum and broad zygomata giving the skull a brachycephalic appearance. Sagittal and nuchal crests poorly developed. Rostrum has longitudinal depression running along nasal sutures. Left and right alisphenoid tympanic wings of auditory bullae well developed and widely separated. The foramen pseudovale large, open and not bisected by a bridge of alisphenoid. Eustachean canal opening large. Internal jugular canal foramina large; canals raised and prominent. Posterior lacerate foramina large and exposed, as are entocarotid foramina. Premaxillary vacuity extends from level of I^2 root back to level of posterior edge of C^1 root. Small maxillary vacuities extend from level of posterior root of P^3 back to level of protocone root of M^3. Palatine vacuities extend from level of protocone root on M^3.

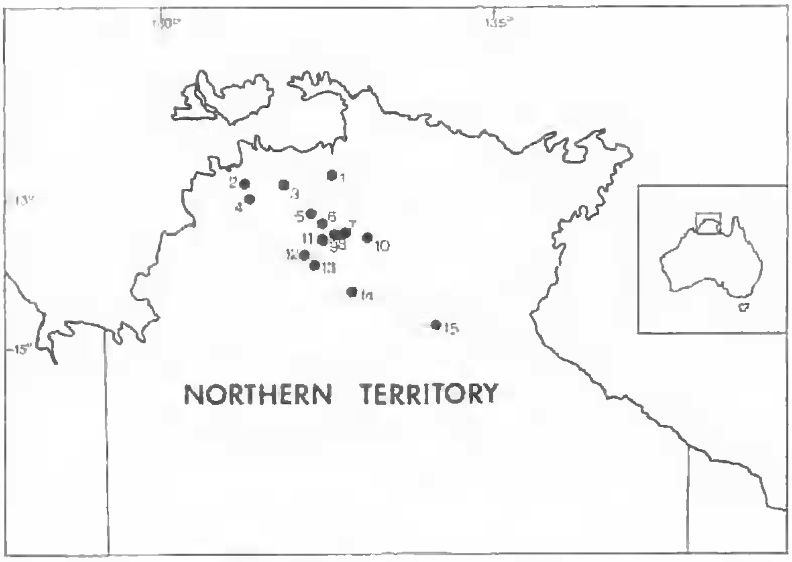

FIG. 6. Collection records for *Sminthopsis bindi* sorted by latitude. 1, West of Kapalga (12°46'S 132°15'E); 2, Stuart Hwy (12°51'S 131°08'E); 3, Arnhem Hwy (12°53'S 131°40'E); 4, Coomalie (13°01'S 131°07'E); 5, Snake Plain (13°12'S 132°16'E); 6, Gerowie (13°23'S 132°16'E); 7, Koolpin (13°30'S 132°35'E); 8, Plumtree Ck (13°31'S 132°27'E); 9, El Sharana (13°31'S 132°33'E); 10, Mt Evelyn (13°31'S 132°56'E); 11, Mary R (13°38'S 132°16'E); 12, Pine Ck (13°50'S 131°53'E); 13, Mt Todd (14°07'S 132°08'E); 14, Eva Valley (14°30'S 132°45'E); 15, Roper Valley (14°55'S 133°54'E).

Variation in Paratypes

In male CM15587 (juv) dP^3 is molariform, 3-rooted, with homologues of a protocone, paracone, metacone and stylar cusp B. M^4 is unerupted. dP_3 is premolariform, 2-rooted, circular in occlusal view, and with buccal and lingual cingula. The entoconids on M_2 and M_3 are moderately well developed.

In male NTMU716 the upper canines are premolariform and ectoloph indentation in M^4 is pronounced. The apical granules on each interdigital pad of the hind feet appear worn and calloused and striation is indistinct.

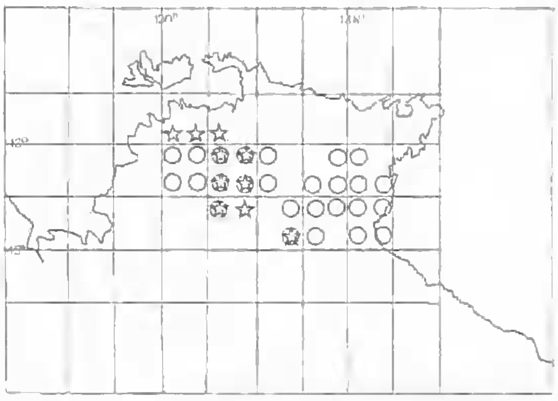

FIG. 7. Distribution of records of *Sminthopsis bindi* by 30' blocks (stars) along with BIOCLIM predictions (circles).

In adult male NTMU946 (a road-killed specimen) the head and body are badly squashed and the teeth show marked signs of decalcification.

The undeveloped pouch of subadult female NTMU954 shows 8 undeveloped nipples. The tail of this specimen is slightly thickened, giving the impression that it had the potential to incrassate.

The basicranium of adult male QMJM10121 is missing. Entoconids of the left dentary are low while those of the right are high and well developed. The right P_2 is abnormally developed with a high posterior cusp and matching abnormal development of the posterolingual lobe.

While hallucal granules were present on the hindfeet of the holotype and all paratypes, no metatarsal granules were recorded. Their presence in dried skin CM15587 was impossible to determine. Most specimens showed enlargement of one or two granules adjacent to either distal or proximal extremity of the prominent striated apical granule on each interdigital pad.

TABLE 3. Distribution of characters states used to resolve the affinities of *S. bindi*. Characters are defined in the derived state.

M. lo	10020	01100	00100	00000	01000	00000	02111	10000	00000	00000	10200	00010	00100	10000	01000	0010
A. go	11112	11101	10100	11101	10101	00101	03222	11011	01110	00000	00200	00003	20110	11000	10000	0001
S. ar	00020	01000	00100	31101	10010	00203	04122	31010	01010	01000	01320	10523	11210	11001	00000	0002
S. bi	00020	01000	00100	31110	10110	00203	04112	21010	01121	01010	01310	10523	11210	11001	00000	0002
S. bu	00021	01000	10100	20100	10111	00203	13132	21010	01011	01000	01320	10743	11210	11002	00000	0001
S. cr	00011	01100	01100	30111	00101	00203	04122	21010	01010	00000	01200	11103	21210	12103	00000	0002
S. do	23112	41021	00100	11200	20211	00212	03132	31010	01121	01010	00300	10543	11210	11100	00000	0001
S. gra	10034	12400	00101	00000	02101	00202	05121	21010	14100	00200	00310	10003	11210	12104	00000	0002
S. gri	01110	01100	00100	31121	10101	00202	04132	21010	11111	00000	00310	10203	11210	11002	00000	0002
S. hi	20010	01001	00100	31010	00100	00202	05222	21010	21011	00000	00320	10433	11221	11108	00000	0002
S. le	11011	01100	01100	30110	10000	00202	04122	21010	00110	00000	00320	10013	11210	11001	00000	0002
S. lo	01221	01301	00100	43342	02101	00203	05123	11010	00110	00100	01320	10023	01232	10015	02000	0002
S. ma	00020	01100	00100	30110	10100	00202	03122	21010	00121	01010	0310	10343	11210	11002	00000	0002
S. mu	01000	01100	00100	30010	10111	00202	04122	21010	12011	01000	00320	10313	11210	11002	00000	0002
S. oo	05014	01001	10100	41121	10200	00203	05122	31010	03121	01000	01320	10103	21210	11102	00000	0003
S. ps	04124	02310	10100	30000	01001	00202	14111	41022	20100	00200	01310	10203	01220	10014	00000	0001
S. vi	11021	01110	00100	20100	20110	00102	03112	21010	01010	01000	00200	10643	11210	11000	00000	0001
S. yo	02111	01100	00100	30111	10200	00203	05132	21010	21021	00000	00320	10113	11220	12107	00000	0003
S. la	01023	01000	00100	44342	01000	00202	04122	41010	00000	00000	01320	10513	11232	10016	10000	0101

Abbreviations: *M. lo=M. longicaudata; A. go=A. godmani; S. ar=S. archeri, S. bi=S. bindi; S. bu=S. butleri; S. cr=S. crassicaudata; S. do=S. douglasi; S. gra=S. granulipes; S. gri=S. griseoventer; S. hi=S. hirtipes; S. le=S. leucopus; S. lo=S.longicaudata; S. ma=S. macroura; S. mu=S. murina; S. oo=S. ooldea; S. ps=S. psammophila; S. vi=S. virginiae; S. yo=S. youngsoni; S. la=S. (A.) laniger.*

REPRODUCTION

Paratypes CM15587 (collected 25 Oct 1980), NTMU943 (22 Feb 1991) and NTMU945 (4 Nov 1990) were probably newly weaned juveniles. U954 had 8 minute non-lactating nipples in a poorly developed pouch lined with long white hairs. No other substantial information is available for the species.

DISTRIBUTION

All known records are from the Top End of the Northern Territory (Fig. 6), with more than half being from the c.7000km^2 Stage III of Kakadu National Park. The distribution of records by 30' blocks is shown in Fig. 7 along with that predicted by BIOCLIM based on sixteen climatic parameters (Table 5). The species is predicted to occur in much of eastern and southern Arnhem Land, areas which have been subjected to remarkably little wildlife survey to date.

HABITAT

S. bindi has been recorded mainly from stony hills with woodland dominated by *Eucalyptus dichromophloia, E. tintinnans* (formerly *E. alba* in part), *E. tectifica*, and *E. foelscheana*. In the Kakadu Stage III area, *Sminthopsis bindi* is closely associated with gravel or stony substrates on rolling foothills and supporting woodland dominated usually by the partly deciduous *E. dichromophloia* and *E. tintinnans* (Woinarski, 1992) (Fig. 8). These substrate and topographic associations are consistent for most records beyond Kakadu, how-

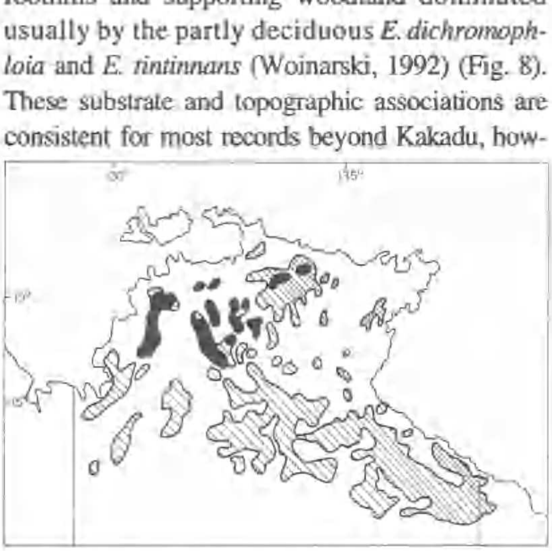

FIG. 8. Northern Territory distribution of *Eucalyptus tintinnans/E. dichromophloia* woodland (solid) and *E. dichromophloia* woodlands (hatched).

TABLE 4. Measurements for holotype (H) and paratypes of *Sminthopsis bindi*. Some abbreviations are as follows: BL basicranial length; ZW zygomatic width; IO interorbital width (measured dorsally); R-LC^1 width of rostrum outside right and left upper canines; R-LM^{1}s width of skull from outside right and left upper first molars; R-LM^{1}m width of skull between right and left upper first molars; HB head-body length (tip of nose to cloaca); TV tail-vent length; $HF_{(su)}$ hind-foot length; $E_{(n)}$ ear length; Wt weight in g. * measurement taken from spirit specimen.

Reg. No.	Age/ Sex	BL	ZW	IO	R-L C^1	R-L M2s	R-L M2m	I^1-M^4	$P1^{-3}$	M^{1-4}	I_1-M_4	I_1-cond	P_{1-3}	$M1_{-4}$	HB	TV	HF	E	Wt
U944 (H)	AM	24.4	14.7	4.1	4.3	9.4	6.8	13.1	3.5	5.5	11.3	19.9	3.3	6.0	74*	105	16.7	17.3*	
U716	AM	22.7	13.5	3.9	4.3	9.1	6.9	12.4	3.4	5.6	10.9	17.8	2.9	6.2	79	99	15.3*	18.2*	14
JM 10121	AM	Cranial fragments and hindquarters only, found at Ghost Bat Roost														103*	16.6*		
U946	AM	Squashed body and skull													90	84	16.4*	19.6*	12
U954	SAF														66*	81*	15.5*	15.6*	
CM 15587	JM	19.2	11.8	3.9	3.8	8.0	6.2								64	70	14.2	13.6	6
U943	JM														65	68*	14.7*	13.8*	

ever vegetation at the Roper River Valley site was predominantly *Acacia* thicket.

PHYLOGENETIC ANALYSIS

The distribution of character states for 79 characters (Table 2) among *Antechinus godmani*, *Murexia longicaudata*, *Antechinomys laniger* and 16 extant species of *Sminthopsis* is listed in Table 3. The phylogenetic analysis associated with this description was aimed primarily at evaluating the affinities of *S. bindi* with the *S. macroura* group (*S. macroura*, *S. butleri*, *S. virginiae*, *S. douglasi*, *S. hirtipes*, Archer, 1981; to which *S. archeri* was more recently added, Van Dyck, 1986). However, it is possible to suggest some of the broader relationships within the genus. When *A. godmani* and *M. longicaudata* comprised the outgroup, this analysis produced a single, well-resolved cladogram of dunnart relationships with 351 steps and a consistency index of 0.41 (Fig. 5). If a hypothetical ancestor exhibiting the presumed pleisomorphic states for all 79 charactersis was included in the analysis, one tree (366 steps, ci 0.42) of identical topology was resolved.

These analyses resolved the 17 tested species into 4 clades: 1, the broad *S. crassicaudata* clade comprised of sub-clades (a) *S. crassicaudata*, (b) *S. ooldea*, (c) *S. longicaudata* and *S.* (*Antechinomys*) *laniger*, (d) *S. hirtipes* and *S. youngsoni*; 2, The *S. psammophila* clade containing *S. psammophila* and *S. granulipes*; 3, The broad *S. macroura* clade comprised of sub-clades (a) *S. griseoventer*, (b) *S. murina*, (c) *S. macroura*, and (d) *S. bindi*, *S. butleri*, *S. virginiae*, *S. douglasi* and *S. archeri* (all from tropical northern Australia); 4, the *S. leucopus* clade containing *S. leucopus* alone. They supported the sister group relationships proposed by Archer (1981) for *S. virginiae* with *S. douglasi* and *S. psammophila* with *S. granulipes*. However, the analysis did not support a hypothesis of sister species relationship between *S. hirtipes* and *S. butleri*; *S. crassicaudata* and *S. laniger*; or a close relationship between his *S. longicaudata* and the *S. ooldea*, *S. murina*, *S. leucopus* clade. While in the present analysis, resolution of *Sminthopsis* cladograms

TABLE 5. Climatic envelope (16 parameters) from locations of capture for *Sminthopsis bindi*.

	Mean	S.D.
Annual mean temperature °C	27.0	0.4
Minimum temp. (coolest month) °C	14.3	1.4
Maximum temp. (warmest month) °C	36.7	0.6
Annual temp. range °C	22.3	1.9
Mean temp. (coolest quarter) °C	23.3	0.9
Mean temp. (warmest quarter) °C	29.8	0.3
Mean temp. (wettest quarter) °C	28.5	0.3
Mean temp. (driest quarter) °C	23.4	0.9
Annual mean precipitation mm	1240	163
Precipitation (wettest month) mm	282	32
Precipitation (driest month) mm	1	0
CV (monthly precipitation)	115	1.8
Precipitation (wettest quarter) mm	790	97
Precipitation (warmest quarter) mm	421	75
Precipitation (driest quarter) mm	6	1
Precipitation (coolest quarter) mm	8	4

varied with the selection of outgroup species, the relationships between the most external members of the *S. macroura* clade (*S. bindi*, *S.archeri*, *S. butleri*, *S. virginiae* and *S. douglasi*) remained robust. The affinities of *bindi* lie with this 'broad-faced' sub-clade of dunnarts of which it is the most plesiomorphic species and of which *S. virginiae* and *S. douglasi* are the most derived.

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